

Diesel NO_x Emission Reduction Technologies

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Review of Area Air Quality Plans

- **Senate Bill 5 established a program to fund projects to reduce NO_x emissions from most diesel engines**
- **Houston-Galveston Area SIP plans allow for offsets of mandated control measures with other emission reductions**
- **Texas expects voluntary emission reductions**

Review of Diesel Emission Reduction Technologies

- **Overview of technologies**
- **Verification status and reduction potential**
- **Cost effectiveness estimates**
- **Recommendations for improvements**

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Technology Review

- **Fuel options** (cetane enhancers, Fischer-Tropsch, fuel/water emulsions)
- **New engine/equipment/vehicle** (accelerated turnover to lower emitting engines (diesel or CNG/LNG), possible hybrid-electric designs)
- **Retrofit technologies** (water injection or inlet air humidification, injection modifications, more extensive engine modification, EGR, lean NO_x catalysts, SCR, NO_x adsorbers, plasma catalysts)

Fuel Measures

- **Fuel reformulation (EPA review documents)**
 - Cetane enhancers
 - (decreases NO_x by 1 to 2 %)
 - Other diesel reformulation
 - 12 to 14% reduction from Texas Low Emission Diesel (LED) possible
 - Fuel/water emulsions
 - 13% from on-road and 20% from off-road engines

New Engine\Vehicle Options

- **Most prevalent project type**
 - Certified engines
- **Accelerated turnover approach**
 - On-road engines pull ahead to 2004 standards
 - Off-road Tier 2/3 engines
- **CNG/LNG moderately lower emitting than diesel engines**
- **Could include hybrid-electric drive trains**

Potential Retrofit Options

- **Options (expected % reduction)**
 - Water injection or Humidified inlet air (~20%)
 - Injection timing modification (~25%)
 - EGR (up to 50% reduction)
 - Lean NOx reduction catalysts (20 - 35%)
 - Selective Catalytic Reduction (up to 90%)
 - NOx adsorber or plasma catalysts (up to 90%; only prototypes available)
- **No retrofit options have been given verification**

Other Retrofit Options

- **Turbine engines (power source with low NO_x emissions)**
- **Electrification; replace either diesel or SI engines**
- **Fuel or Solar Cells**
- **Retrofit of SI three-way catalysts**

Cost Effectiveness

- **Two kinds of Cost Effectiveness**
 - annualized over life of project
 - 1-year where total cost divided by annual reduction
- **California Carl Moyer experience**
 - On-road projects - \$5,200/ton, annualized
 - Off-road projects - \$2,500/ton, annualized
 - Overall 1-year cost effectiveness; \$19,000/ton
- **TERP experience;**
 - ~\$10,000/ton annualized
 - ~\$40,000/ton 1-year cost effectiveness

Recommendations

- **Compare cost effectiveness of measures to offset required emission controls**
- **Mid-course review of HGA SIP will change the nature of control measures and other opportunities**